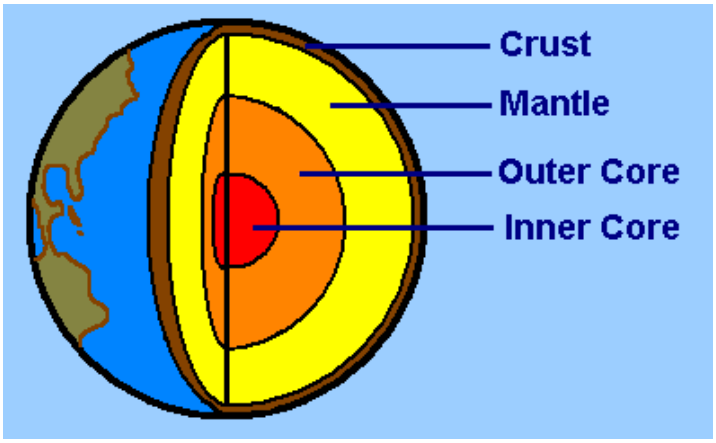
SUPPORTING SCIENCE AND TECHNOLOGY EDUCATION

ROCK MY WORLD – FOSSILS AND EARTHQUAKES



Teacher Manual

HOUSE OF SCIENCE

HUTT CITY
TE AWA KAIRANGI

CONTENTS

KIT CONTENTS

- Teacher Manual
- Student Activity Cards 10 for each of the 4 activities (red, orange, yellow and green)
- Inflatable World Globe
- A3 diagram model of the Earth
- 10 small bags with modelling clay (3 colours) and sand
- Cotton thread to cut the modelling clay globes
- 10 boxes of rocks
- 10 boxes of fossils
- 10 magnifying glasses
- Cooking oil spray
- 10 plaster of paris containers
- 10 shells
- Ice block sticks
- 10 tectonic plate puzzles
- A3 tectonic puzzle master
- 10 clear A3 sheets
- 10 whiteboard markers
- 10 jars of sand
- 10 building bricks
- 10 tin trays

LEARNING OUTCOMES AND CURRICULUM LINKS

Activity	Curr Level	Conceptual Learning Outcomes	NoS Learning Outcomes	Science Capability
Structure of the Earth	1/2	**Planet Earth and Beyond; Earth Systems (L1/2)** Explore and describe natural features and resources	**Investigating in Science L1/2** Extend their experiences and personal explanations of the natural world through exploration, play, asking questions and discussing simple models.	Interpret representations (model of the Earth and its layers)
Fossils	1/2/3	**Planet Earth and Beyond; Earth Systems** **L1/2** Explore and describe natural features and resources **L3** Appreciate that water, air, rocks and soil, and life forms make up our planet and recognize that these are also Earth's resources.	**Investigating in science (L3)** Ask questions, find evidence, explore simple models and carry out investigations to develop simple explanations.	Gather and Interpret data Use evidence
Tectonic Plates	1/2/3	**Planet Earth and Beyond; Earth Systems** **L1/2** Explore and describe natural features and resources **L3** Appreciate that water, air, rocks and soil, and life forms make up our planet and recognize that these are also Earth's resources.	**Investigating in science** Carry out science investigations using a variety of approaches: classifying and identifying, pattern seeking, exploring, investigating models, fair testing, making things, or developing systems.	Use evidence
Liquefaction	1/2/3/4	**Planet Earth and Beyond; Earth Systems** **L1/2** Explore and describe natural features and resources **L3** Appreciate that water, air, rocks and soil, and life forms make up our planet and recognize that these are also Earth's resources. **L4** Develop an understanding that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources.	**Participating and contributing** Bring a scientific perspective to decisions and actions as appropriate.	Engage with Science

SCIENCE CAPABILITIES

The 5 Science Capabilities are based around asking questions that encourage students to think like a scientist. Here is a list of questions that can be used in many different scenarios:

Capability 1: Gather and interpret data

To help differentiate between observation and inference you can use the following questions:

- Is it something you can see, hear, smell, touch or taste?
- Is it measurable?
- What did you see? (observation)
- What might that mean? (inference)

Capability 2: Use evidence

To show the use of evidence based on observations of the natural world, make sure your explanations answer the following questions:

- What makes you think so?
- How do you know that?
- How could you check that?
- So an example of this would be...

Capability 3: Critique evidence

To help evaluate the reliability and validity of data use the following questions to critique an investigation:

- How were the measurements taken and recorded? How confident are you that the measurements are accurate?
- Did these results surprise you? What were you expecting to find out?
- Would these results always be true?

Capability 4: Interpret representations

To help you think about how data is presented in a resource or model use the following questions:

- What does this representation tell you?
- How does this representation get the message across?
- Why is it presented in this particular way?

Capability 5: Engage with science

As you actively engage with real life science issues relevant to your community, discuss:

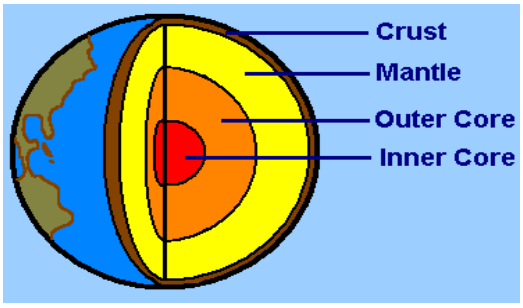
- What is the science behind this issue?
- What do others think?
- What logical connections can be made?
- What reasonable conclusions can be drawn here?

TEACHER BACKGROUND NOTES AND ACTIVITIES

1. Structure of the Earth

Big idea: Under its "living" cover of soil and vegetation the Earth's surface is rock.

Notes for teachers



The Earth is almost a sphere. These are its main layers, starting with the outermost:

1. **crust** - relatively thin and rocky, solid
2. **mantle** – liquid, molten rock which can flow very slowly (like thick toffee)
3. **outer core** - made from liquid nickel and iron
4. **inner core** - made from solid nickel and iron (solid due to the pressure from the outer layers)

Student Activity – Modelling clay model of the Earth

1. Show a globe to the class. Talk about the different countries. Where do we live? Discuss countries students have visited or perhaps used to live. Ask students, "What shape is the Earth?" Emphasise that we live on a sphere. Tell students "We live *on* the Earth, but I wonder what's *inside* the Earth?" Record students' ideas about what is inside the Earth.
2. Look at the image above. Discuss the layers with the students.
3. Students use modelling clay to model what is inside the Earth. *
4. Red = Inner Core, Orange = outer core, yellow = mantle, sand = crust
5. Instruct groups to cut the ball in half using the cotton. Opened up, students can visually understand the different layers

*Modelling clay does not go back to the kit once formed into a globe.

Questions:

- What layer of the Earth do the different colours of clay represent?
- How do scientists know what the Earth looks like on the inside? (Over many years scientists have collected data using specialised monitoring equipment. They put this data together to make an **inference** about the structure of the Earth).

Further extension ideas:

A. Scale model of the Earth and its layers

Inner core = 1,287 km (0.6cm)
Outer core = 2,253 km (1.1cm)
Mantle = 2,897 km (1.4cm)
Continental plate = 24 km (very thin)

Explain to students that for each layer of their models, one centimetre represents 2,000 kilometres.

Have students form the inner core using the red clay. (The ball of clay representing the inner core should have a diameter of about 0.6 centimetres.)

The second layer of the model is the outer core. Use the orange clay to add 1.1 cm layer over the red ball of clay (their inner core). The outer core layer, when added, brings the diameter of the ball to about 2.8 centimetres.

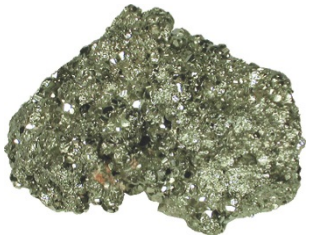
The third layer is the mantle. Use the yellow clay to add 1.4 cm layer over the orange layer. Adding the mantle layer brings the ball up to a diameter of 5.6 centimetres.

Since it is difficult to make a sheet of clay less than one millimetre thick, use a thin layer of sand to represent the crust of the Earth. Ask students to carefully spread the sand, as evenly as possible, on a piece of paper on their desks. Then roll the ball in the sand.

Instruct groups to cut the ball in half using the cotton. Opened up, students can visually understand the different layers and compare their thicknesses.

B. Rock Identification

Many different types of rocks can be found on the Earth's crust. The types of chemicals in the rock, the conditions it was formed under (eg temperature, pressure, etc) and its location results in the formation of many different kinds of rocks and gemstones that differ in their properties and appearance. Use the magnifying glass and the Rock identification chart to identify the different rocks in the 'Rock Box'. What visible features do they have? Choose your favourite rock and use the class's research resources to find out 3 facts about it – where it comes from, what it's made of, what uses it has, etc.

 **Amethyst** – purple, crystalline	 **Rose Quartz** – pink, crystals	 **Geode** – crust with clear crystals
 **Quartz** – clear crystals	 **Red Jasper** – dark red, opaque	 **Turquoise** – blue, opaque
 **Unakite** – green and pink, opaque	 **Pyrite** – metallic flecks	 **Tiger's eye** – golden brown, banded

 **Adventurine** – green, opaque	 **Flourite** – blue, clear, purple crystal	 **Agate** – grey, opaque

2. Fossils

Big Ideas:

- Fossils are the preserved remains of living things or of traces of their activities and are usually found in rocks.
- Fossils give us clues about the past.
- Many plants and animals that lived on Earth in the past can no longer be seen alive.

Notes for teachers

Fossilisation of dead living things is not common as fossils are only formed if the organisms' remains do not decompose but are buried in an anaerobic environment. Therefore, the body of the organism must be buried in a place that bacteria and other decomposers do not live – a peat bog, under volcanic ash, at the bottom of the ocean under sediment, etc. Structures such as bones, teeth and shell can be turned to rock over millions of years and, if the conditions are right, they may be brought to the surface of the crust.

Imprints or casts of some living things can also be made. Shells and leaves can form casts.

Student Activity – Plaster Cast fossil

1. Write your team name on the side of a paper cup.
2. Tip the Plaster of Paris from the container into a paper cup.
3. Fill up the container to the water line and add to the Plaster of Paris. Stir well with the ice block stick.
4. Allow the plaster to semi harden for 3 minutes
5. Spray the scallop shell with cooking spray
6. Carefully place the shell into the cup so that the edges are just above the plaster level.
7. Set aside to harden overnight (minimum of 4 hours)
8. Tear the cup to remove the set plaster from the cup
9. Gently remove the shell to reveal the fossil cast. *

*Shells must be returned to the box NOT thrown away.

Questions:

- How is this cast similar to a fossil? (Same size and shape as the original shell).
- How is it different? (It didn't take very long to make, it is a cast, not a 3D fossil).

Further Extension Ideas:

A. Fossil Identification

Using a magnifying glass and the Fossil Identification Card, look at the fossils in the Fossil Box and identify them.

B. Fossil creative writing

Students choose a fossil and discuss the organism it may have come from. Students can draw a picture of what this organism would have looked like.

 **Ammonite**	 **Shark tooth**	 **Crinoids**
 **Brachiopods**	 **Florida snail shell**	 **Bivalve shell**

3. Tectonic Plates

Big ideas:

- Earthquakes are caused by movement of the Earth's crust.
- NZ is located at the active boundary between 2 tectonic plates, and earthquakes play an important role in shaping our landscape.

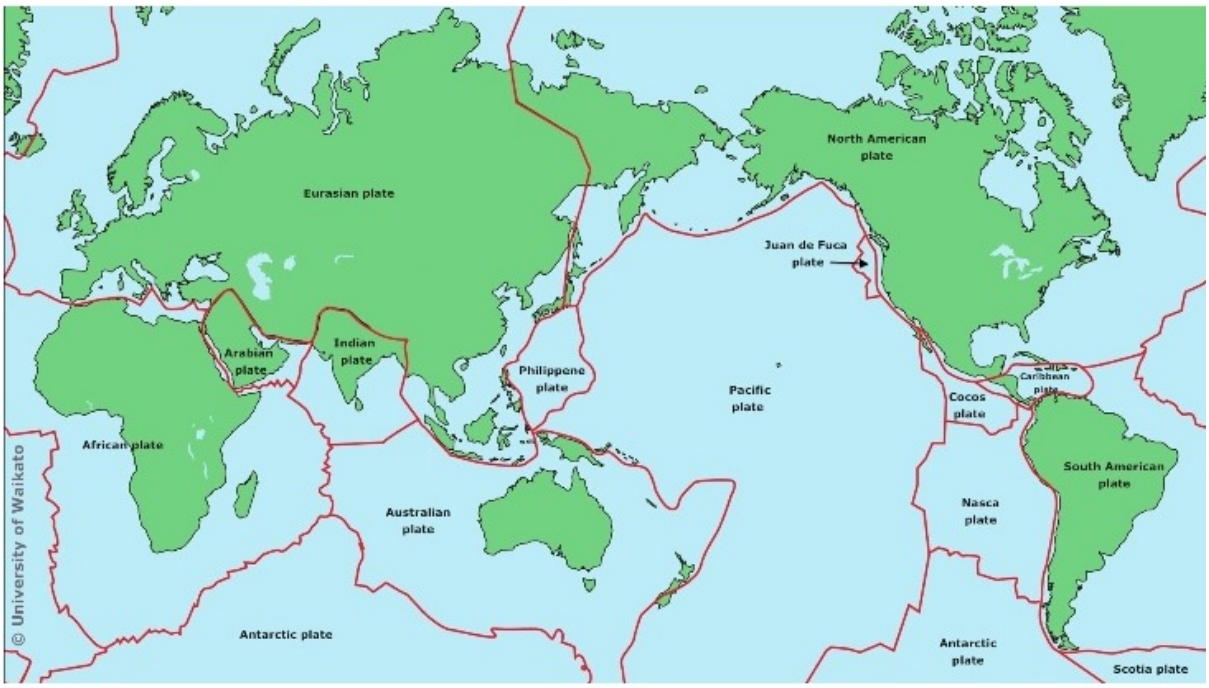
Notes for Teachers

The surface of the Earth (the crust) is made up of large separate plates or areas that fit together rather like a huge jigsaw. The plates – which are the outermost layer of the Earth – are more rigid than the layer below. These plates ride on the hotter and more fluid layer underneath (the upper part of the mantle), sometimes moving apart, sometimes moving past each other and other times pushing together at plate boundaries. It is at tectonic plate boundaries where energy builds up as plates push and move against each other. When the pressure gets too much, something has to give, and an earthquake can happen.

Magma is semi-solid rock under the Earth's crust. It cannot get through the many kilometres of crust that forms the ground we walk on. Only in certain areas where the crust is fractured or broken – like at the edge of a tectonic plate boundary – can the molten mantle start to creep through and form a volcano.

In this activity, students are introduced to tectonic plates and how they fit together. They can visualise the breaks under the ground and begin to see why New Zealand and other areas around the Pacific Ring of Fire are home to so many volcanoes and earthquakes. (Copied from Science Learning Hub)

<u>Student Activity</u> – Tectonic Plate Puzzle



1. Hold up the world globe and discuss the shape of the Earth and New Zealand's location. Recap the different layers of the Earth.
2. Complete the Tectonic Plate Puzzle

<u>Questions:</u>

- Which plate is New Zealand on?
- Which plate is Australia on?
- From this map use evidence to discuss similarities between New Zealand and Japan

3. Lay a clear A3 sheet over the completed puzzle. Children can pinpoint the locations of 10 large earthquakes on this sheet using white board markers.

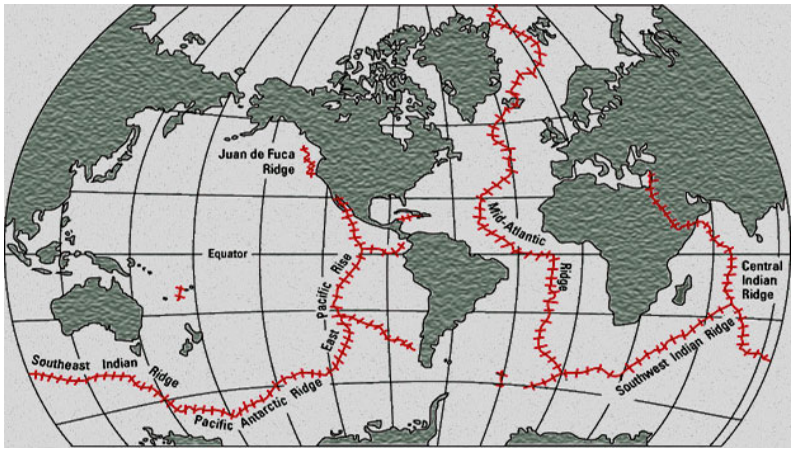
<u>Questions:</u>

- What do you notice about where Earthquakes are? (close to tectonic plate **boundaries**)
- Is Australia likely to have an earthquake anytime soon? No. Why not? It's not near a tectonic plate **boundary**.

Further extension ideas:

Show students the interactive Volcano map of New Zealand (http://sciencelearn.org.nz/Contexts/

Volcanoes/ Sci-Media/Animations-and-Interactives/Volcano-map-of-New-Zealand) or underwater mountains. See if students can match the locations of our volcanoes to the plate boundaries between the Pacific and Australian Plates.



4. Liquefaction – turning sand into a liquid

Big idea: The strength and depth of an earthquake combined with the type of ground cause changes to the landscape.

Notes for Teachers

How an earthquake feels depends on its location and the location of the observer. One key factor is the physical properties of the soil and surface sediments. Soil usually has elastic properties but vibrations can cause non elastic behaviour such as slumping of loose material or liquefaction of sandy soil.

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction can cause major damage during an earthquake

Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other.

Student Activity - Liquefaction

1. Empty the sand container into the shallow tray
2. Fill the jar with water to the level shown
3. Tip half this water over the sand and stir with the iceblock stick
4. Tip the remaining water over the sand, mix and roughly flatten. Do not shake the container at this stage
5. Place block on top representing a house – ask children what is happening at this stage (the 'house' should be supported by the wet soil)
6. Get the children to gently tap the sides of the container (they could all do a side each) and observe what happens to the "house". (it gradually sinks and water rises)
7. You can repeat this by stirring the sand again and roughly smoothing it.

*Please dispose of the sand in your school grounds. Do not return to the kit.

Questions:

- What effect do you think a large earthquake might have on sandy land or reclaimed land from the harbour? Why?
- What parts of our local area are reclaimed land?

RESOURCES AND LINKS

Name	Comments	Website
Ministry of Education	These books should be in your teacher resource section. Building Science Concepts Book 2: Weathering and Erosion Book 12: Volcanoes Book 40: Earthquakes Book 41: Fossils Book 52: The land changes Making Better Sense of the Planet Earth and Beyond	scienceonline.tki.org.nz/What-do-my-students-need-to-learn/Building-Science-Concepts/Titles-and-concept-overviews
Science Learning Hub	A comprehensive selection of resources and activities on this topic available on this NZ website.	sciencelearn.org.nz
GNS Science	Be inspired to appreciate the amazing story being uncovered by New Zealand geoscientists.	www.gns.cri.nz
Te Ara The Encylopedia of NZ	A reliable source of quality reading material, images and video on fossils.	www.teara.govt.nz/en/fossils/page-1 www.teara.govt.nz/en/earthquakes/page-1

APPENDIX

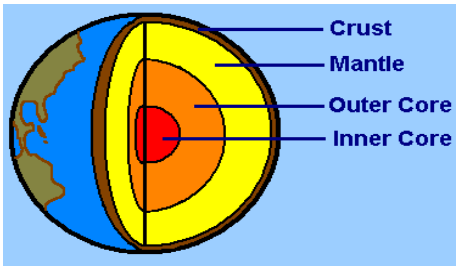
Student instruction sheets

ROCK MY WORLD – FOSSILS AND EARTHQUAKES

Structure of the Earth

STUDENT INSTRUCTION SHEET

Instructions:



1. Collect the equipment for your group:
   - Red modelling clay
   - Yellow modelling clay
   - Orange modelling
   - Small bag of sand
2. Roll the **red** piece of modelling clay in a ball. This represents the Earth's inner core.
3. Flatten the **orange** piece of modelling clay and wrap it evenly around the inner core. This represents the Earth's outer core.
4. Flatten the **yellow** piece of modelling clay and wrap it evenly around the outer core. This represents the mantle.
5. Roll the model of the Earth in the sand so it is covered all over. This represents the crust.
6. Wrap the cotton thread around your fingers and cut the model of the Earth in half.

Questions:

What layer of the Earth do the different colours of clay represent?

How do scientists know what the Earth looks like on the inside?

Rock Identification:

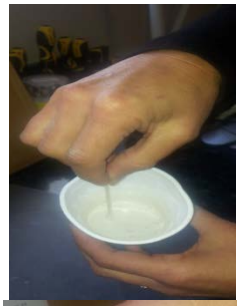
Use the magnifying glass and the Rock ID chart (see over) to identify the different rocks in the 'Rock Box'. What visible features do they have? Choose your favourite rock and find out 3 facts about it – where it comes from, what it's made of, what uses it has, etc.

ROCK MY WORLD – FOSSILS AND EARTHQUAKES

Fossils

STUDENT INSTRUCTION SHEET

Plaster Cast fossils



1. Write your team name on the side of a paper cup.
2. Tip the Plaster of Paris powder from the container into the labelled cup.
3. Fill the container with water to the water line. Add this to the Plaster of Paris. Stir well with the ice block stick.
4. Allow the plaster to rest for about 3 minutes
5. Spray the scallop shell with cooking spray
6. Carefully place the shell into the cup so that the edges are just above the plaster level. Make sure the "outside" of the shell is the side pressed into the plaster.
7. Set aside to harden overnight (minimum of 4 hours)
8. Tear the cup to remove the set plaster from the cup.
9. Gently remove the shell to reveal the fossil cast.

*Shells must be returned to the box do NOT throw away.

Questions:

- How is this cast similar to a fossil?
- How is it different to a fossil?

Fossil Identification

Use the magnifying glass and the fossil ID chart (see over) to identify the different fossils in the 'Fossil Box'. What visible features do they have? Choose your favourite fossil and find out 3 facts about it – where it was found, what it is embedded in, the organism it came from etc.

ROCK MY WORLD – FOSSILS AND EARTHQUAKES

Tectonic Plates

STUDENT INSTRUCTION SHEET

1. Take the pieces from the bag and fit them together to form the puzzle. Use the words on the puzzle and the shapes of continents and countries that you already know to help you.

Questions:

- Which plate is New Zealand on?
- Which plate is Australia on?
- How is New Zealand similar to Japan?

2. Take a clear A3 sheet and lay this over your complete puzzle.

3. Use a whiteboard marker to mark the locations of these large earthquakes. You may need a copy of the world map to help you.

Location	Date	Magnitude
Honshu Island, **Japan**	2011	9.0
Christchurch, **NZ**	2011	6.3
Sumatra, **Indonesia**	2004	9.3
New Ireland region, **Papua New Guinea**	2000	8.0
Panay, **Philippines**	1948	8.3
Gulf of Izmit, **Turkey**	1999	7.6
Gulf of Aqaba, **Saudi Arabia**	1995	7.3
Santiago del Estero, **Argentina**	2011	7.0
Acapulco, **Mexico**	2014	7.2
San Francisco, **USA**	1906	7.8

Questions:

- What do you notice about the location of the earthquakes?
- Is Australia likely to have an earthquake anytime soon? Why/Why not?

Liquefaction

STUDENT INSTRUCTION SHEET

1. Empty the sand from the jar in the shallow tray
2. Fill the jar with water to the level shown.
3. Tip half of this water over the sand and stir with the ice block stick.
4. Tip the remaining water over the sand, mix and roughly flatten with the stick. Do not shake the container to flatten at this stage!
5. Place the brick on top of the sand on its short side. This represents a building.
6. Gently tap the sides of the container and observe what happens to the "building".
7. Stir the sand and roughly smooth it again to have another go.

Your teacher will tell you how to dispose of the sand

Questions:

- What effect do you think a large earthquake might have on sandy land or reclaimed land from the harbour? Why?
- What parts of our local area are reclaimed land?